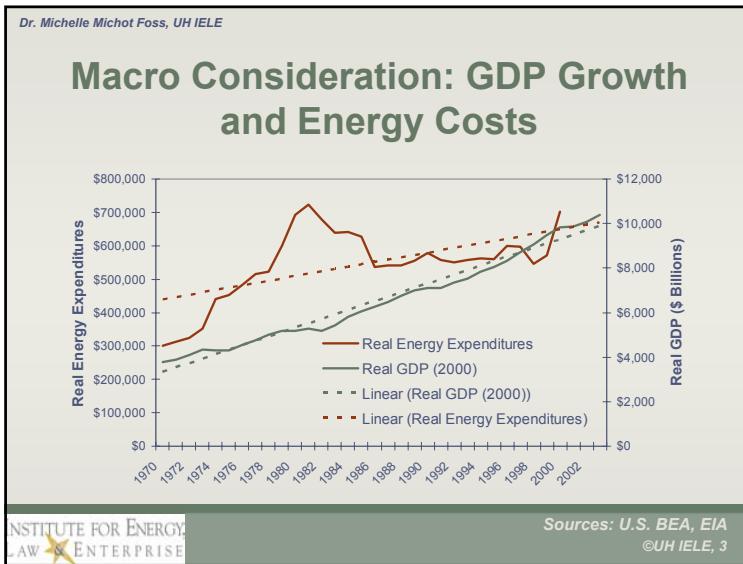


UNIVERSITY OF HOUSTON LAW CENTER  
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## LNG: Can We Build It?



Dr. Michelle Michot Foss, UH IELE

## Balancing Our Energy Future

**What do we want?**

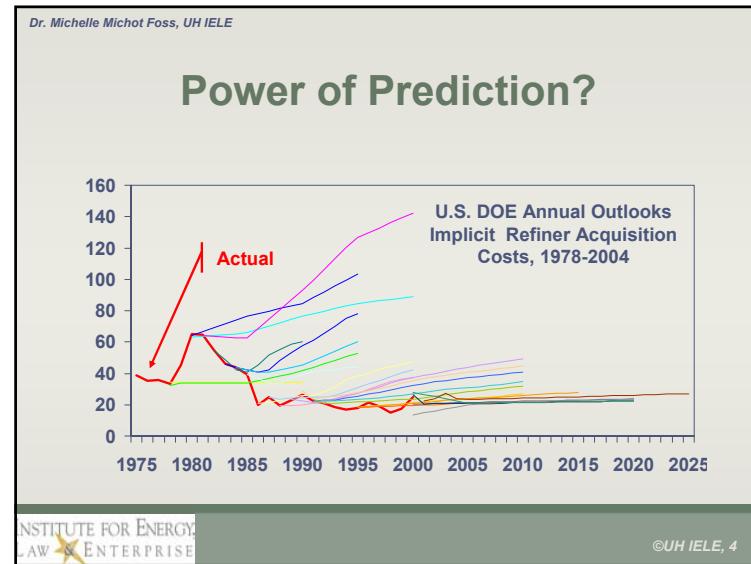
**How do we get there?**

- “Safe, clean, affordable, (abundant) energy” → Natural gas is a desirable alternative, but resource and infrastructure must be developed
- “Reduced risk of disruptions, price volatility” ← Portfolio including both supply diversity, demand-side response – can LNG help?
- “Secure, commercially successful operations” ← LNG import facility design subject to market and economic constraints

**Best practice design at a price the market will bear.**

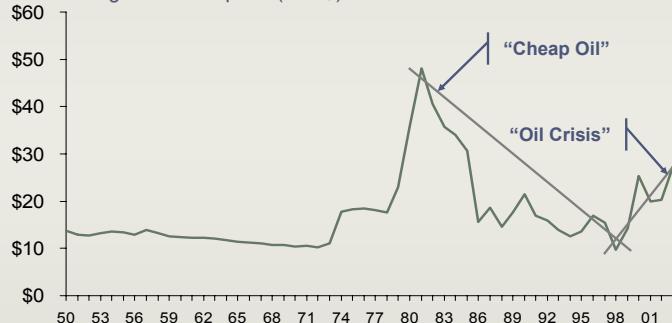
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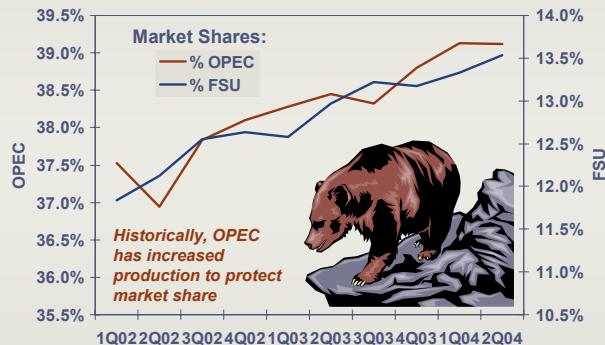
## Power of Prediction?

U.S. average wellhead price (real \$)



Source: U.S. EIA  
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## OPEC and Russia



Source: IEA, U.S. EIA  
©UH IELE, 7

## Technology vs. “Peak Oil”

Cumulative U.S. Oil & Gas Production, 1950-2002  
MMBOE (Includes Alaska)

- Hydrates? GTL?

- Offshore below 10,000ft

- 4-d seismic, offshore below 5,000ft

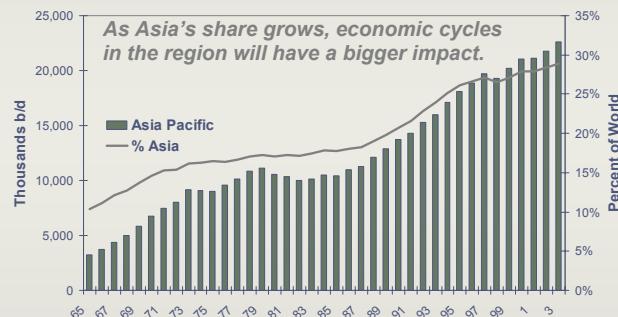
What peak?

- 3-d seismic, horizontal drilling, measurement while drilling, offshore below 1,000ft
- Pipeline trenching and welding, compression, pressure control, metering; national grid develops
- Directional drilling, offshore below 250ft water depth
- Long-line pipeline transmission
- Advances in drilling, early seismic, shallow offshore E&P

•Oil discovered at Spindletop (Texas), 1901  
•Oil discovered in Titusville, Pennsylvania, 1859; natural gas replaces town gas, 1870s

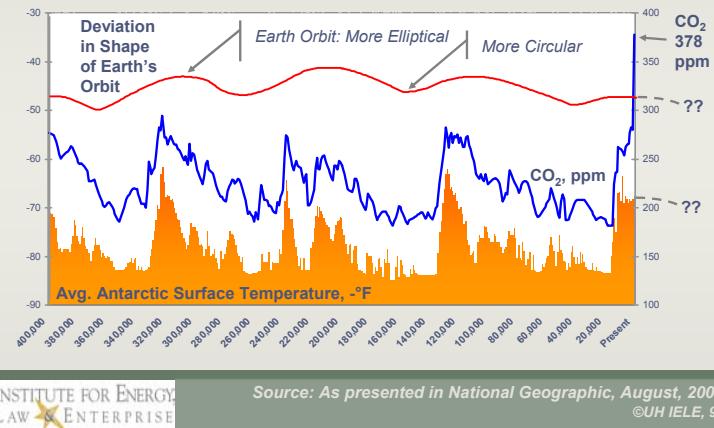
IT Pathway	Mainframes	Minis	Micros	Work Stations	?
1850	1900	1930	1940	1950	1960 1970 1980 1990 2000 Not to scale

## The Asian “Gulp”



Sources: BP Statistical Review of World Energy, 2004  
©UH IELE, 8

## A Rich Country Problem



## Key Points

- LNG is already an important part of the U.S. energy mix, both imported and domestic storage/peak management

## North American Market, 2003, Bcf



## Key Points

- LNG is already an important part of the U.S. energy mix, for both imports and domestic storage/peak management
- The cost of the LNG value chain is such that economies of scale matter

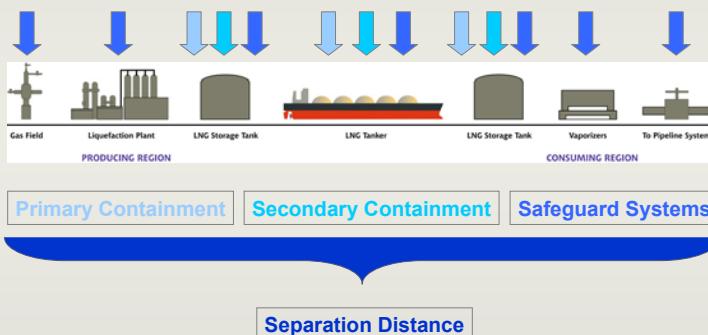
## LNG Value Chain



**TOTAL = \$2.00 - \$3.70**

*Greatest variability is in upstream feedstock for liquefaction and shipping distance.*

### Example Applications of Multiple Layers of Protection Along the LNG Value Chain



## Key Points

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- North America provides a crucial link between Atlantic and Pacific Basin LNG trade

## Global Gas Market Evolution and Arbitrage: Why North America Matters

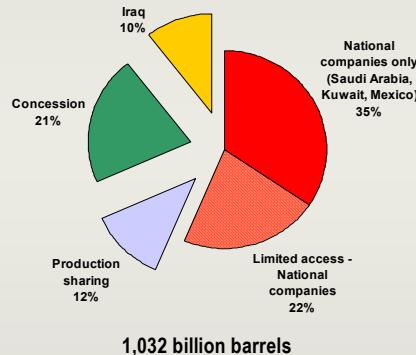


- Key considerations:**
- Economic regulation of terminals
  - Pipeline takeaway capacity
  - NGL content of LNG cargos vs. terminal design and pipeline standards (interchangeability)
  - Evolution of short term LNG contracting mechanisms
  - Oil vs. gas Btu pricing

## LNG Value Chain Shipping opportunities



## Who's in Control?

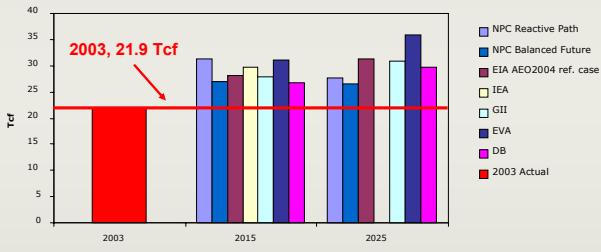


## Key Points

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- Even conservative natural gas demand outlooks are difficult to supply without LNG

## Long Term U.S. Outlook for Demand

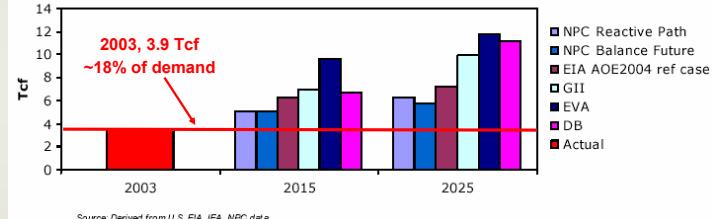
Total U.S. demand projected to be **26.5 Tcf** in 2015, **29.7 Tcf** in 2025  
(U.S. EIA reference case)



Sources: EIA, IEA, NPC and others

## Long Term U.S. Import Requirements

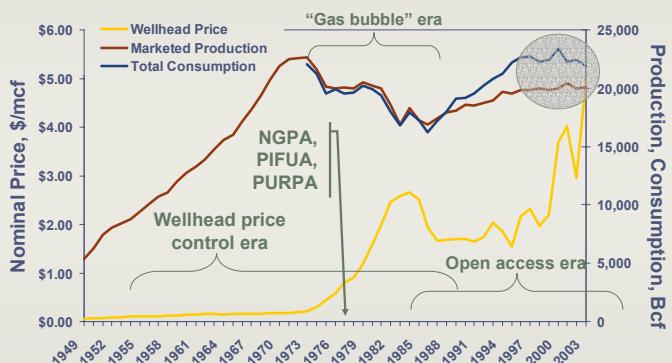
Total U.S. imports projected to be **6.2 Tcf** in 2015, **7.2 Tcf** in 2025  
(U.S. EIA reference case)



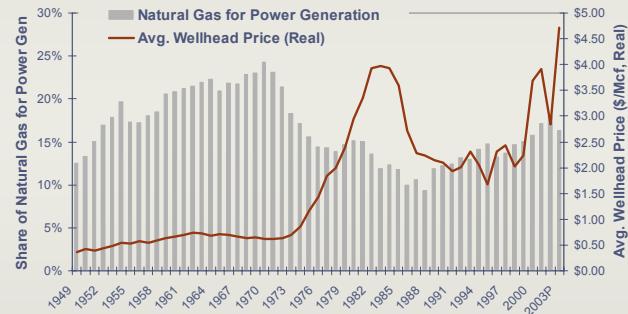
Source: Derived from U.S. EIA, IEA, NPC data

UH IELE, The Role of LNG in North American Natural Gas Supply-Demand Balances, 2004 (forthcoming).

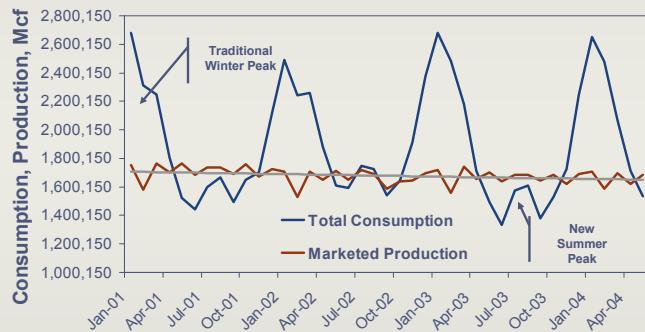
## Just the Facts, Ma'am



## Cleaner Burning Natural Gas for Electric Power



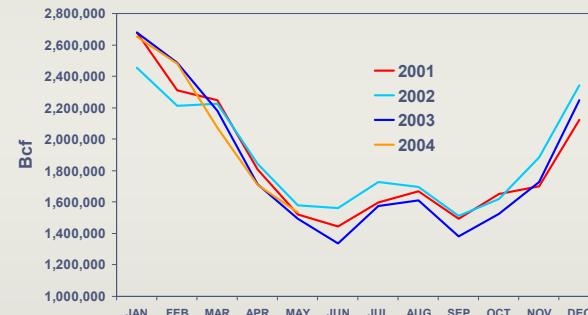
## U.S. Natural Gas Consumption, Production



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Source: U.S. EIA  
©UH IELE, 25

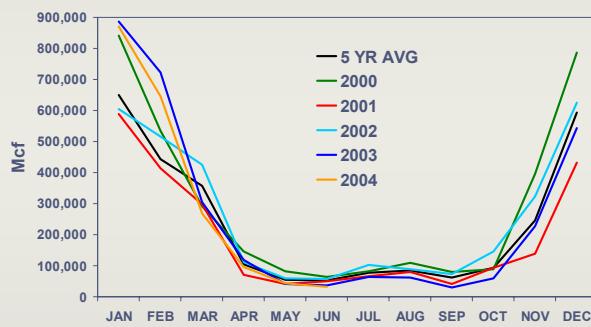
## U.S. Total Consumption



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Source: U.S. EIA  
©UH IELE, 26

## U.S. Natural Gas Storage Withdrawals



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Source: U.S. EIA  
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## Short Term: LNG Takes Up the Slack as a “Price Taker”



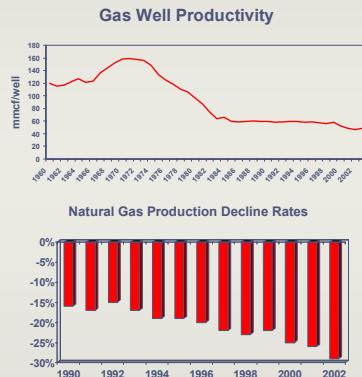
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Source: U.S. EIA  
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## Changing dynamics of U.S. Gas Market

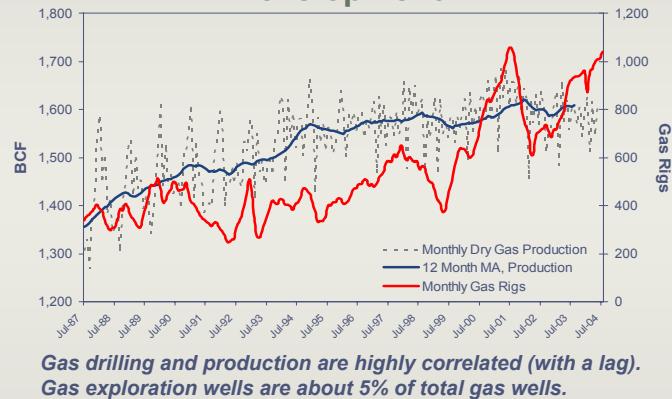
### Declining well Productivity and increasing decline rates

- Many fields are several decades old and are declining rapidly.
- New natural gas reserves are being discovered, but with advanced recovery technologies these fields are quickly depleted.
- Most production flows from wells not more than three years old.



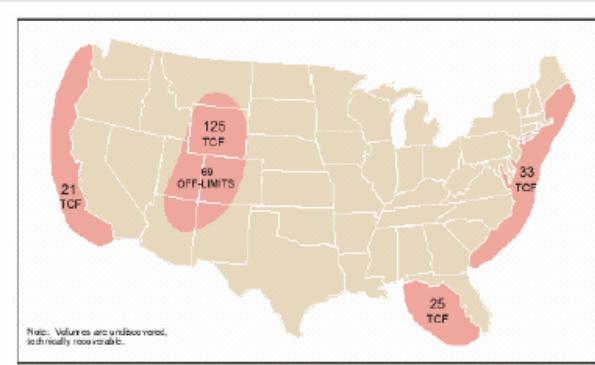
Source: U.S. EIA  
©UH IELE, 29

## U.S. Gas Resource “Just in Time” Development



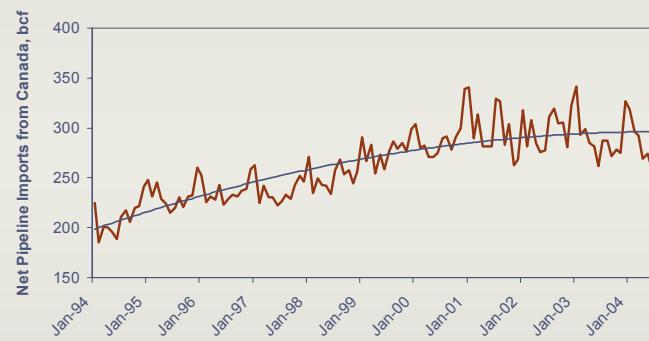
Source: U.S. EIA, Baker Hughes  
©UH IELE, 30

## Access is a Real Issue



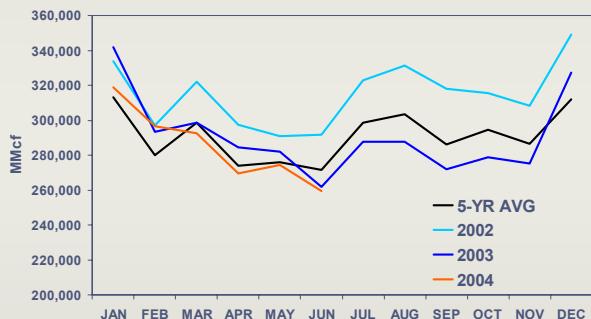
Source: NPC  
©UH IELE, 31

## Canadian Pipeline Export Trend



Source: U.S. EIA  
©UH IELE, 32

## Seasonal Canadian Pipeline Exports

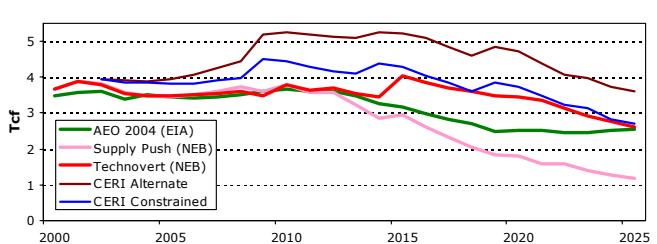


## Canadian Production Trend

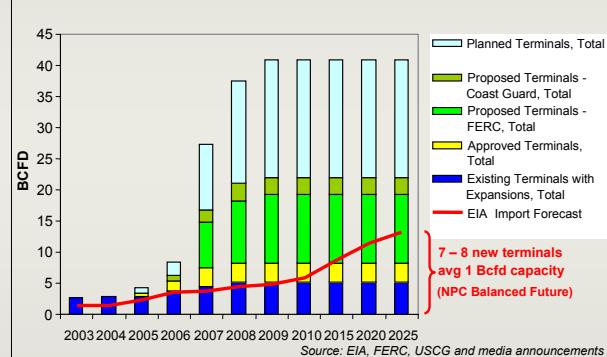
Canadian natural gas production



## Long Term Outlooks for Canadian Exports



## Aggregate of Known LNG Projects: Unsustainable Development



## UH IELE Outlook: “Current Path”



## Key Points

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- North America provides a crucial link between Atlantic and Pacific Basin LNG trade
- Even conservative natural gas demand outlooks are difficult to supply without LNG
- We can learn a great deal from international experience

## Case Study: Japan

	U.S.	Japan
Liquefaction/export terminal	1	
Import terminals	4	23
Peakshaving facilities	57	
Satellite storage facilities (w/ and w/o liquefaction) and other	51	26

- Historically strong collaboration between industry and government given lack of land area for large setbacks
- 10-year planning cycle with METI
- Binding agreements with prefecture/local governments
- Going forward – public concerns toward industrial development, lack of developable sites means more creative use of existing infrastructure and new commercial arrangements

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- Even conservative natural gas demand outlooks are difficult to supply without LNG
- We can learn a great deal from international experience
- America enjoys privileged status with respect to private sector investment for energy infrastructure**

## For More Information

- Public education initiatives - examples
  - University of Houston, Institute for Energy, Law & Enterprise, <http://www.energy.uh.edu/lng>
  - Center for LNG  
<http://www.lngfacts.org/>
  - The DOE/NARUC LNG partnership  
<http://www.naruc.org/programs/lng/> announced by Secretary of Energy Spencer Abraham in Sept. 2003
  - Gas Processors Association (GPA) LNG committee  
<http://www.gasprocessors.com/lng.html>
  - SITTO film on LNG (under advisement)  
<http://www.sigitto.org/>
  - The International LNG Alliance (ILNGA) [www.ilnga.org](http://www.ilnga.org)

## IELE LNG Research Consortium: [www.energy.uh.edu/lng](http://www.energy.uh.edu/lng)

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